Mars Observer Ground Support Equipment Collection
1986-1994
JPL 271

History

Mars Observer was programmed to be the first mission returning to Mars since the 1976 Viking missions. Basing its design on civilian and military Earth-orbiting spacecraft designs controlled spacecraft development costs. General Electric's Astro-Space Division produced the Mars Observer spacecraft carrier vehicle, or bus. The Titan III launch vehicle was provided by Martin Marietta Commercial Titan, Inc.; the Transfer Orbit Stage (TOS) was supplied by the Orbital Sciences Corporation and built by Martin Marietta Astronautics. Launch Complex 40, the launch site for this mission, located on Cape Canaveral Air Force Station, is the newer of the two East Coast Titan launch facilities, were the final stages of a complete refurbishment by the Bechtel Corporation under contract to the U.S. Air Force is capable of launching both Titan III and Titan IV boosters.

Mars Observer had more than 50 percent of the total spacecraft mass liquid reform at lift –off. Hence, liquid slosh dynamics had a major impact in the three-axis thruster control design for ? V maneuvers. The propellant for Mars Observer was contained in four spherical tanks. The bipropellant fuel Monomethyl Hydrazine (MMH) and the oxidizer were each contained in a 1.07m diameter tank and the monopropellant fuel was contained in two 0.48m diameter tanks. A pendulum modeled the fundamental slosh mode in each tank. The second and higher modes of the liquid motion were neglected because the modal mass associated with each of the higher modes was negligible. The pendulum parameters such as 1 the mass, 2 the length, and 3 the hinge point location of various ? V maneuvers were given. To be conservative, a damping ratio of 0.001 was assumed for all sloshing during the ? V maneuvers.

The Jet Propulsion Laboratory had been assigned management of the project by the Office of Space Science and Application. JPL's responsibilities for acquiring the spacecraft included scientific instruments, conducting of mission operations, and also operating the center for Tracking and Data Acquisition System, and the Space Flight Operations Center. Further, JPL approved the preliminary design review for all eight of the spacecraft's instruments. In addition, the ultra-stable oscillator that JPL was supplying for radio-science investigations passed critical design review while it was undergoing fabrication at the Applied Physics Laboratory of Johns Hopkins University.

The Mission System preparations were concentrated on the development of the Ground Data System (GDS) needed for launch, development and verification of the cruise flight
sequences, final staffing of the flight team, and operations test and training for launch.

The GDS supporting of flight was in place and operating, except for the Verification Test Laboratory (VTL) that was delivered shortly by General Electric Astro-Space Division (GE-ASD). Additional capabilities needed for launch had been added to this version of the GDS. The launch GDS testing was scheduled to be completed by June 15, 1992. A set of five sequences in compressed form was run on the spacecraft at GE-ASD to ensure GDS compatibility with the spacecraft. The final spacecraft-DSN-GDS end-to-end test was run on the spacecraft at the Eastern Test Range in Florida in July.

Mars Observer was launched on September 25, 1992, aboard a Titan III launch vehicle from Cape Canaveral Air Force Station in Florida. The objective of the Mars Observer mission was to place a spacecraft in parking orbit around Earth by the Titan III launch vehicle and then be injected onto the trans-Mars heliocentric trajectory by the TOS upper-stage vehicle about Mars for one Martian year (687days) providing a nadir-oriented platform from which to carry out a series of cost-effective experiments and measurements designed to meet the scientific objectives of the mission. The spacecraft was to be inserted into an intermediate-phasing orbit. This orbit was adjusted to a circular Sun-synchronous mapping orbit at approximately 360-km altitude and 93° inclination toward the planet's equator.

The science investigations utilized instruments and experiments selected to cover the measurement objectives for mineralogical, elemental, and condensation abundance; temperature, ozone, water, and dust

profiles; and topography and magnetic field.

Mars Observer had completed an 11-month, 711-million-kilometer (442-million-mile) journey to Mars and was within three days of entering orbit around the planet when it fell silent at about 1:00 Universal Time on August 22, 1993.

The spacecraft was about to begin pressurizing its fuel tanks in preparation for the August 24th orbit-insertion maneuver when its transmitters were turned off and the spacecraft was never heard from again. It was the first loss of a United States planetary mission in 22 years.

In conclusion of Mars Observer operations, JPL attempted the last realistic chance to validate that the spacecraft still existed and was properly operating-except for its telemetry transmitter. That occurred in late September, during a search for a beacon from a radio relay system onboard the spacecraft by radio astronomy antennas at Jodrell Bank in England, at Stanford University, and at the Goldstone tracking facility near Barstow.

A study team, chaired by Dr. Charles Elachi, Assistant Laboratory Director at the time, for the Office of Space Science and Instruments, did evaluate all of the possible options for contacting the spacecraft including those that did involve international cooperation, and heard proposals from the United States industry in November. Formal recommendations were expected to be presented to NASA Headquarters on November 18, 1993.

A NASA review board spent several months investigating the loss and concluded that the most plausible theory was that a critical failure in the propulsion system disabled Mars Observer several days before arriving at Mars. The board recommended changes to the design to prevent such an occurrence from happening on Mars Global Surveyor, Mars Climate Orbiter (1998) and the Mars Surveyor 2001 Orbiter.

Provenance

Louie Frausto was a clerk in Section 348 – Flight Command and Data Management Systems, which merged with Section 345 and is now Section 344, Avionics Equipment. It is believed the Department Group Supervisor, E. C. Litty, Section 343 assigned Frausto at the time, to empty out the department's filing cabinets, etc. He was instructed to box the documents, label them and transfer the material to the Archives. Therefore, Frausto was the collector and Litty was the originator. Further, in November of 1999, when the material was transferred; the shipment of 49 boxes was split into 8 separate Accessions once received in the Archives; Accessions 99-24 through 99-31. This is Accession 99-26.

Collection Description and Arrangement

The collection arrangement includes 117 folders in 16 boxes. This consists of ground support equipment material on the Mars Observer Spacecraft from 1986 through 1994.

Collection Organization

The collection contains a chronological file folder list of ground support equipment Critical Design Reviews generated by contractor GE Astro Space Division under contract number 957444. The documents in this collection include Mars Observer Attitude & Articulations Control Subsystem (AACS), Command & Data Handling, Mechanics, Date Time Group (DTG) Pads, various drawings, MO data packages, Optical Decoders, Reaction Wheel Assembly, and the Gimbal Drive Electronics Unit.

The GDE consisted of two redundant units within a common assembly. The GDE was devoted to either; 1) interfacing between the Control Interface Unit (CIT) and the Solar Array Gimbal Drive Assembly (SAGD), or 2) Antenna Gimbal Drive Assembly (AGDA). This included, receiving and decoding a 16 bit serial motor command word, providing optimization of stepper motor drive pulses for minimum power dissipation, providing status telemetry, and providing a hardware stop at the maximum limits of both antenna solar array rotation.

JPL Discreet Material

Folder Number 84 contained one document labeled Discreet. However, the remainder of the material in folder 84 is non-discreet and reviewable. The Discreet document has been placed in a box at the end of the collection. Hence, a separation sheet has been placed in folder 84 to indicate the removal of the document.

Conservation/Preservation

Standard preparations of documents for long term storage were completed.

Separation Statement

No materials were separated from the collection.

Finding Aids

There are no other finding aids.

File Folder List

File titles as found were retained.

Box 1 of 17

Fld 1 Mars Observer. Miscellaneous Drawings (Test 510), Part 1 of 2; March 1986.

Fld 2 Part 2 of 2.

Fld 3 Mars Observer. Miscellaneous Drawings (514), February 1987.

Fld 4 Mars Observer. Honeywell Inertial Measurement Unit (IMU) Preliminary Design Review (PDR); March 1987.

Fld 5 Mars Observer. Date Time Group (DTG) Preliminary Design Review, Part 1 of 2; March 1987.

Fld 6 Mars Observer. Part 2 of 2.

Box 2 of 17

Fld 7 Mars Observer. DTG IMU PDR Actions, March 1987.

Fld 8 Mars Observer. DTG IMU PDR, Part 1 of 2; March 1987.

Fld 9 Mars Observer. Part 2 of 2.

Fld 10 Mars Observer. IMU PDR Actions Responses, March 1987.

Fld 11 Mars Observer. Final Report Mechanisms Subsystem PDR, May 1987.

Fld 12 Mars Observer. Acceptance Test Plan, May 1987.

Fld 13 Mars Observer. Strap Down Gyro (SDG) – 5 Gyro For DTG IMU, June 1987.

Fld 14 Mars Observer. Miscellaneous Drawings, August 1987.

Fld 15 Mars Observer. Honeywell DTG IMU Critical Design Review, No Date.

Box 3 of 17

Fld 16 Mars Observer. Inter-Office Memoranda, September 1987.

Fld 17 Mars Observer. IMU Critical Design Review, September 1987.

Fld 18 Mars Observer. DTG IMU Critical Design Review, Part 1 of 2; September 1987.

Fld 19 Mars Observer. Part 2 of 2.

Fld 20 Mars Observer. IMU DTG Test Review, October 1987.

Fld 21 Mars Observer. In Flight and Mars Orbit Vibrations, April 1988.

Fld 22 Mars Observer. Inter-Office Memoranda, September 1988.

Fld 23 Mars Observer. Inter-Office Memoranda, October 1988.

Fld 24 Mars Observer. Mechanism Subsystem, **?** PDR, Part 1 of 2; October 1988.

Fld 25 Mars Observer. Part 2 of 2

Fld 26. Mars Observer. Inter-Office Memoranda, November 1988.

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Fld 27 Mars Observer. MO-AAC–001–1 Thru MO–Attitude & Articulation Control-001-096, Part 1 of 3; October 1986 – November 1988.

Fld 28 Mars Observer. Part 2 of 3.

Fld 29 Mars Observer. Part 3 of 3.

Fld 30 Mars Observer. IMU Requirement Verification Plan, November 1988.

Fld 31 Mars Observer. Miscellaneous Drawings, November 1988.

Fld 32 Mars Observer. Miscellaneous Drawings, November 1988.

Fld 33 Mars Observer. Drawings – 327891, No Date.

Box 5 of 17

Fld 34 Mars Observer. MO-PE-001 & MO – SE-001, 003, 004, 005, February 1988 – January 1989.

Fld 35 Mars Observer. Inter-Office Memoranda, January 1989.

Fld 36 Mars Observer. Electromagnetic Compatibility (EMC) Test Plan, February 1989.

Fld 37 Mars Observer. Honeywell Avionics (DTG –MO Thermal) Stress CDR, March 1989.

Fld 38 Mars Observer. Gimbal Drive Electronics (GDE) Preliminary Design Review, March 1989.

Fld 39 Mars Observer. Material and Process List, April 1989.

Fld 39A Mars Observer. Honeywell Miscellaneous Data, April 1989.

Fld 40 Mars Observer. 4 – 20 Control Panel Assembly, Part 1 of 2; May 1989.

Fld 41 Mars Observer. Part 2 of 2.

Box 6 of 17

Fld 42 Mars Observer. IMU & Control Subsystem (CS) Radiation Analysis CDR Data Submittal, May 1989.

Fld 43 Mars Observer. MO DTG – IMU, May 1989.

Fld 44 Mars Observer. IMU Fracture Analysis CDR Data Submittal, May 1989.

Fld 45 Mars Observer. IMU Failure Mode Effects and Criticality Analysis (FMECA) CDR Data Submittal Per General Electric 2624719, Part 1 of 3; May 1989.

Fld 46 Mars Observer. Part 2 of 3.

Fld 47 Mars Observer. Part 3 of 3.

Fld 48 Mars Observer. IMU Mechanical Stress Analysis CDR Submittal, May 1989.

Fld 49 Mars Observer. IMU – Inertial Measurement Unit, Part 1 of 2; May 1989.

Fld 50 Mars Observer. Part 2 of 2.

Box 7 of 17

Fld 51 Mars Observer. Reaction Wheel Assembly (RWA) CDR, Book 2 of 2, Part 1 of 3; July 1989.

Fld 52 Mars Observer. Book 2 of 3, Part 2 of 3; July 1989.

Fld 53 Mars Observer. Book 2 of 3, Part 3 of 3; July 1989.

Fld 54 Mars Observer. Reaction Wheel Assembly (RWA) CDR Data Package, Book 1 of 2, Part 1 of 2; July 1989.

Fld 55 Mars Observer. Book 1 of 2, Part 2 of 2; July 1989.

Fld 56 Mars Observer. Critical Design Review for Astro Space Division, August 1989.

Fld 57 Mars Observer. Costing & Scheduling – Code Identification Number: 49671, August 1989.

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Fld 58 Mars Observer. MO-AAC–001–100 – Thru MO–AAC– 001 – 139, Part 1 of 3; February 1988 – August 1989.

Fld 59 Mars Observer. Part 2 of 3; August 1989.

Fld 60 Mars Observer. Part 3 of 3; August 1989.

Fld 61 Mars Observer. Gimbal Drive Electronics (GDE) CDR, August 1989.

Fld 62 Mars Observer. Optical Decoder Miscellaneous Data, August 1989.

Fld 63 Mars Observer. Gimbal Drive Electronics (GDE) CDR, Book 1 of 3; August 1989.

Fld 64 Mars Observer. Gimbal Drive Electronics (GDE) CDR, Book 2 of 3, Part 1 of 3; August 1989.

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Fld 65 Mars Observer. Book 2 of 3, Part 2 of 3; August 1989.

Fld 66 Mars Observer. Book 2 of 3, Part 3 of 3; August 1989.

Fld 67 Mars Observer. Gimbal Drive Electronics (GDE) CDR, Book 3 of 3, Part 1 of 2; August 1989.

Fld 68 Mars Observer. Book 3 of 3, Part 2 of 2; August 1989.

Fld 69 Mars Observer. BEI (Motion Systems Co.), Specification Drawings; September 1989.

Fld 70 Mars Observer. BEI (Motion Systems Co.), September 1989.

Box 10 of 17

Fld 71 Mars Observer. Mechanism Subsystem Critical Design Review, Vol. II, Book 2 of 2; September 1989.

Fld 72 Mars Observer. Mechanism Subsystem Critical Design Review, Vol. III, Book 1 of 4; September 1989.

Fld 73 Mars Observer. Mechanism Subsystem Critical Design Review, Vol. III, Book 3 of 4; September 1989.

Fld 74 Mars Observer. Recommendation for Action (RFA), October 1989.

Fld 75 Mars Observer. Inter-Office Memoranda, October 1989.

Fld 76 Mars Observer. Critical Design Review for Astro Space Division, February-October 1989.

Fld 77 Mars Observer. Astro Space Division Data, Part 1 of 3; October 1989.

Fld 78 Mars Observer. Part 2 of 3; October 1989.

Fld 79 Mars Observer. Part 3 of 3; October 1989.

Fld 80 Mars Observer. Mechanisms Subsystem CDR, Book 1 of 2; October 1989.

Fld 81 Mars Observer. Mechanisms Subsystem CDR, Book 2 of 2; October 1989.

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Fld 82 Mars Observer. Optical Decoder, Part 1 of 2; October 1989.

Fld 83 Mars Observer. Part 2 of 2.

Fld 84 Mars Observer. Optical Encoder Light-Emitting Diodes (LED), October 1989.

Fld 85 Mars Observer. Inter-Office Memoranda, January 1990.

Fld 86 Mars Observer. Gyro Investigation Report Text, January 1990.

Fld 87 Mars Observer. Gyro Investigation Report Data, January 1990.

Fld 88 Mars Observer. BEI Data (Motion Systems Co.), January 1990.

Fld 89 Mars Observer. Optical Decoder Assembly Miscellaneous, January 1990.

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Fld 90 Mars Observer. BEI MO Encoder Miscellaneous Data, Part 1 of 2; January 1990.

Fld 91 Mars Observer. Part 2 of 2.

Fld 92 Mars Observer. Gimbal Actuator Type-5 Critical Design Review, Part 1 of 2; February 1990.

Fld 93 Mars Observer. Part 2 of 2; January 1990.

Fld 94 Mars Observer. MO-AAC-001-140 Thru MO-AAC-001-185, Part 1 of 2; August 1989-March 1990.

Fld 95 Mars Observer. Part 2 of 2; August 1989-March 1990.

Box 13 of 17

Fld 96 Mars Observer. SD/AAC-10, Attitude & Articulation Control Subsystem & Miscellaneous, Part 1 of 2; March 1990.

Fld 97 Mars Observer. Part 2 of 2, March 1990.

Fld 98 Mars Observer. MO-Shipping & Handling/Eng., Part 1 of 2; April 1989-March 1990.

Fld 99 Mars Observer. Part 2 of 2, April 1989-March 1990.

Fld 100 Mars Observer. Command Data Handling/Eng-002-13, May 1989-April 1990.

Fld 101 Mars Observer. Inter-Office Memorandum Responses to CDR Spacecraft System, April-May 1990.

Fld 102 Mars Observer. Spacecraft Parts for Flight Software, November 1988-May 1990.

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Fld 103 Mars Observer. GE-ASD Memorandum Index Listing, July 1990.

Fld 104 Mars Observer. Q-Flex Accelerometer Silver Epoxy, Part 1 of 4; August 1988-October 1990.

Fld 105 Mars Observer. Part 2 of 4, August 1988-October 1990.

Fld 106 Mars Observer. Part 3 of 4, August 1988-October 1990.

Fld 107 Mars Observer. Part 4 of 4, August 1988-October 1990.

Fld 108 Mars Observer. Wavier & Nonstandard Part Approval Request (NSPAR) Status, May 1990-October 1990.

Box 15 of 17

Fld 109 Mar Observer. IMU Photo Flight Test Procedure, September 1990.

Fld 110 Mars Observer. MO-AAC-002 – MO-AAC-003 – MO-AI-025; MO-AI-002-003, Part 1 of 2; September 1989-December 1990.

Fld 111 Mars Observer. Part 2 of 2; September 1989-December 1990.

Fld 112 Mars Observer. MO Test Discrepancy Report & Problem Failure Reports, April 1990-May 1990.

Fld 113 Mars Observer. Magellan & RSR's, August 1993.

Fld 114 Mars Observer. Interoffice Memoranda, Part 1 of 2; October 1993.

Fld 115 Mars Observer. Part 2 of 2, October 1993.

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Fld 116 Mars Observer. Environmental Operating Support Equipment (OSE), October 1993.

Fld 117 Mars Observer. Part 2 of 2.

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Fld 84 JPL Discreet Document – 1 Folder

Catalog Description
Mars Observer Ground Support Equipment
Collection, 1986-1994.

4.95 c.f. in 17 boxes
Includes all contractor ground support equipment documents critical design reviews and several GSE preliminary design reviews, and interoffice memoranda under contract number 95744 for the Jet Propulsion Laboratory Mars Observer spacecraft project. Produced by General Electric Astro Space Division, East Windsor, New Jersey, BEI (Motion Systems Co), and Honeywell Space and Strategic Avionics Division from 1986-1994.

Register available in the repository.

Tracings
Jet Propulsion Laboratory-History
National Aeronautics and Space Administration-History
Mars Observer Project-History
Mars Observer Spacecraft Ground Equipment-History
General Electric Astro Space Division
BEI (Motion Systems Co)
Honeywell Space and Strategic Avionics Division
UNMANNED SPACECRAFT
INTERPLANETARY SPACECRAFT
SPACE PROBE

DOCUMENTATION
AEROBRAKING
MARS MISSIONS
MARS OBSERVER
SPACECRAFT DESIGN
DESIGN ANALYSIS

Accession 1999-26